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The complex interaction of tone and prominence

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Certain positions in phrases, feet, words and syllables permit a larger range of contrasts than other positions. There is an ongoing debate about the need for, and the division of labor between, positional faithfulness constraints and positional markedness constraints in any account of these facts. This paper investigates this issue within the domain of tone, and concludes that there is no alternative to admitting both positional markedness and positional faithfulness constraints. It further suggests that constraints may have to be positively as well as negatively stated, and that some constraints may have to govern sequences of tones, not just individual tones.

1. Introduction

De Lacy (1999) has proposed an interestingly restrictive theory of the interaction between tone and prominence based on two universal hierarchies of negative positional markedness constraints, one of which regulates the appearance of tones in heads, and one of which regulates their appearance in non-heads. The first hierarchy deals with the preference for H tone over L tone in head syllables by positing constraints that bar certain tones in Head position. So *HD/L means “No L on head syllables”.

(1) *HD/L >> *HD/M >> *HD/H.

It can be used to explain phenomena such as the insertion of H on stressed syllables (Lithuanian), the movement of H to stressed syllables (Zulu, Digo), and the propensity of stress for avoiding L syllables (Golin, Mixtec).

Phenomena such as the deletion of H on unstressed syllables (Vedic Sanskrit), the

movement of H off unstressed syllables (Digo), and the attraction of stress to H syllables (Golin, Mixtec) are dealt with by the second hierarchy, which deals with the preference for L tone over H tone on non-heads:

- (2) *NONHD/H >> *NONHD/M >> *NONHD/L.

De Lacy develops this proposal in detail, and his analysis of a Mixtec dialect is summarized here. Huajuapán Mixtec (Cacaloxtepec) (Pike and Cowan 1967) places stress depending on the tones of a word, as follows:

- (3) a. *Stress the leftmost syllable which is followed by a syllable with a lower tone:*
 HHL sádínà 'he/.she/they/(known) are closing it'
 HML kónāà 'a wide thing'
 MLH ñānìní 'your (sg. adult) brother'
 b. *Otherwise, stress the leftmost syllable:*
 HHH sádíní 'you (sg. adult) are not closing it'
 LLH ðùkùní 'your (sg. adult) niece'

Phonetically, stress is realized as duration, and higher pitch. In the related Ayutla dialect, there is segmental evidence for the stress/non-stress distinction too. In unstressed syllables without onsets, vowels devoice before voiceless consonants, and unstressed vowels may delete if the result is syllabifiable: /sánàrà/ > [snàrà].

De Lacy suggests that the stressed syllable and the following syllable form a binary trochaic foot. The head of the syllable always has a higher tone than the non-head. In the two constraint hierarchies given above, the two highest ranking constraints are *HEAD/L and *NON-HEAD/H. What de Lacy points out is that the three well-formed feet, HM, ML and HL, are exactly the three feet which satisfy both these two conditions. In fact there is one other, too, MM, but de Lacy suggests that this can be ruled out by the OCP applying within the foot. All other tonal feet violate one or more of these constraints.

These constraints (together with FT-FIN and FT-FORM-TROCHEE) define acceptable feet, but the location of the foot - leftmost- requires a further constraint, ALIGN-L(HEAD-σ, PRWD). The relevant portion of the grammar is as follows:

- (4) *HEAD/L, *NONHEAD/H, OCP >> ALIGN-L(HEAD-σ, PRWD)

Let us now see how these constraints produce the desired forms. First consider a case with one falling sequence, not at the left-edge of the word. Stress still falls on the start of that sequence, because the constraints on tonal sequences inside feet out-rank Align-L. Now take a word with two falling sequences. Since both are acceptable feet, they will tie on the three highest-ranked constraints, and Align-L will pick out the leftmost. Finally, consider a case with no falling sequences. Here any footing will violate one of the tonal constraints, so all possible footings will tie and Align-L will again decide things

De Lacy's restrictive and elegant proposal extends to cases he does not consider, and which are the subject of section 2 of this paper, where I offer additional arguments in support of his proposals. The remainder of the paper, however, changes tack, and raises some objections to the most restrictive version of the theory. Specifically, I argue that it may not

be possible to maintain that the grammar includes only negative positional markedness constraints. In section 3 I give an argument that positional faithfulness constraints cannot be dispensed with altogether. In section 4 I argue that positive positional markedness constraints such as “Heads must be H” may be needed. Lastly, in section 5 I give two somewhat speculative arguments for sequential markedness constraints which look at sequences of tones, not just single tones.

2. Three extensions of de Lacy’s theory:

2.1 First extension: Tonal inventory gaps

In Dagaare (Gur, Niger-Congo, NW Ghana, Anttila and Bodomo 1996) there are two tones, H and L. On bi-syllabic nouns we find all possible combinations except LL:

| | | | | |
|-----|----------------|--------------------|-----------------|-----|
| (5) | LH: | HL: | HH: | LL: |
| | bògí ‘hole-SG’ | dóli ‘dry spot-SG’ | kúó ‘rat-SG’ | - |
| | dùó ‘pig-SG’ | kógò ‘mahogany-SG’ | lúgrí ‘prop-SG’ | - |

In de Lacy’s approach, this can be readily understood. First, suppose that in Dagaare, as in most if not all languages, every prosodic word must contain at least one foot. Every foot of course has a head, and if *HD/L is high ranked, at least above DEP-T, then words with no underlying H will get one inserted to satisfy this. Dagaare, under this view, is very much like Lithuanian (de Lacy, Blevins 1993), in which words with no H get one inserted on the accented syllable (underlined):

| | | | |
|-----|---------------------------------|--------------|----------------|
| (6) | /prà-nèʃù/ → [pr <u>à</u> nèʃù] | ‘I announce’ | *HD/L >> DEP-T |
|-----|---------------------------------|--------------|----------------|

2.2 Second extension: Prominence accompanied by simple presence/absence of tone

In many languages (e.g. Mandarin, Shanghai), *all* underlying tones are lost on unstressed syllables, and *all* underlying tones are retained on stressed syllables. Toneless syllables then receive either a default tone at the end of the phonology, or phonetic pitch by interpolation. At first glance this indifference to tonal distinctions might not seem to be predicted by de Lacy’s approach, but in fact while de Lacy’s account allows for discrimination between H and L tones, it does not require it. So languages of this type are what we get when the entire *NON-HEAD/T hierarchy dominates the entire *HEAD/T hierarchy, with MAX-T intervening:

| | |
|-----|---|
| (7) | <i>Ranking for languages with all tones retained on all and only head syllables:</i> *NON-HEAD/H, M, L >> MAX-T >> *HEAD/H, M, L |
|-----|---|

This can usefully be abbreviated as *NONHD/T >> FAITH >> *HD/T.

In addition to the obvious effect of forcing deletion of tone on any syllable identified as a non-head by higher-ranked constraints, this ranking has a less obvious but perhaps more

interesting consequence. Other things being equal, it forces all tone-bearing syllables to be heads of their own feet, and thus mimics algorithms that build feet on tones (Yip 1980, Clements 1981, Huang 1980). *NONHD/T will be violated by any tone-bearing syllable that is not a head. If the tones are deleted so as to create legitimate non-heads, the output will violate FAITHFULNESS. Thus the preferred candidate will be one that satisfies both these highly-ranked constraints by making each syllable a head of its own foot. To make this concrete, consider a bi-syllabic word in Mandarin. Mandarin has left-headed feet, and there are three main candidates for the foot structure and tonal behavior of such a word. In candidate (a), each syllable is its own foot, and also retains its tone. In candidate (b), the syllables are grouped into a binary foot, and tone is retained only on the head. In candidate (c), the foot is also binary, but both tones are retained. Heads are underlined.

(8) *Tableau for full syllables, e.g. Beijing Mandarin /L.H/*

| /L.H/ | *NONHD/T | FAITH | *HD/T |
|----------------------------|----------|-------|-------|
| a. <u>(L)</u> . <u>(H)</u> | | | ** |
| b. <u>(L.∅)</u> | | *! | |
| c. <u>(L.H)</u> | *! | | * |

Candidate (c) violates *NONHD/T, and is quickly ruled out. Candidate (b) violates FAITHFULNESS because one tone has been deleted. Thus candidate (a) wins, since it allows retention of all tones, each of which is head of its own foot. The upshot of this is that tonal deletion will only occur if something else in the grammar requires larger feet, and thus forces some syllables to be non-heads.

2.3 Third extension: Evidence of *NonHd/H and *Head/L at phrasal level in Mandarin

Even though at the foot-level Mandarin has no discernible preference for high over low tone in heads, at higher levels of structure such a preference can be found.

Consider the well known rule of Mandarin “third tone” sandhi, in which the first of a sequence of two low tones changes to high-rising. The OCP-violating input /L.L/, where the dot shows the syllable boundary, is broken up by the insertion of a H, giving [LH.L]. (The sandhi tone in fact surfaces as [MH.L], apparently since MH is part of the tonal inventory whereas LH is not; I abstract away from this issue here, and show the output of sandhi as LH throughout). Interestingly, while the insertion of the H is caused by the OCP, the precise placement of the H follows from de Lacy’s theory, since it is placed on the head of the phrasal unit in preference to the non-head. The domains in which the insertion takes place are preferentially binary, and left-headed. They are not feet, but something larger: see Chen 2000 for discussion. Heads are underlined. The preference for [LH.L] (candidate a) over *[H.L] (candidate b) with deletion of the first L, can be attributed to MAX >> *HEAD/L, and the

triumph of [LH.L] over *[L.HL] (candidate c), with the H on the second syllable, follows directly from *NONHEAD/H. The tableau below shows how this works:

(9)

| /L.L/ | OCP | *NON-HD/H | MAX | *HEAD/L |
|-----------|-----|-----------|-----|---------|
| a. (LH.L) | | | | |
| b. (H.L) | | | *! | |
| c. (L.HL) | | *! | | |
| d. (L.L) | *! | | | |

This is not the only evidence in Mandarin for a preference for H in head position. The phrasing that controls the application of the third-tone sandhi rule is controlled by a number of syntactic and prosodic factors, and in many cases alternate phrasings are available. See Chen (2000) for a recent summary. One of the significant factors is contrastive focus or emphasis. Emphasis re-draws the boundaries in such a way that the emphasized constituent changes from L to MH if possible. It does this by making sure that the focused /L/ is in a constituent with any following L. In isolation, the phrasing of 'only buy stocks' is as given in (a), with two binary phrases. Under focus, it changes to (b), where the emphasized word is phrased with the following L, and thus undergoes tone sandhi, even though this means that the utterance has two undersized unary feet.

(10) a. Normal phrasing:

only buy stocks
 zhi mai gu-piao
 U.R. L LL HM
 Sandhi (LH L)(L HM)

b. Phrasing under contrastive focus:

only buy stocks not sell stocks
 zhi mai gu-piao, bu mai gu-piao
 U.R. L L L HM MH HM L HM
 Sandhi (L) (LH L) (HM)

The effect is to avoid a low-toned head, in satisfaction of *HEAD/L.

A different strategy for avoiding L-toned focused heads may be used in degree adverb-adjective constructions, which may emphasize either adverb or adjective (Hoa:98). The choice depends partly on the tones, avoiding a L tone unless it can be changed to a MH by sandhi. In both the following examples, the adverb *hen* is L-toned. In the first example, the adjective is high-toned, and emphasis is preferred there. In the second example, where both adverb and adjective are underlyingly low, tone sandhi can change the first syllable to high rising, so emphasis is preferred on the first syllable.

(11) *Emphasis placement subject to avoidance of a L-toned syllable.*

| | | |
|------------------|-----|-------------------|
| very heavy | vs. | very small |
| hen <u>zhong</u> | | hen xiao |
| L <u>HM</u> | | L L → <u>MH</u> L |

If a low-toned syllable must be emphasized, a different lexical item is sometimes selected, such as feiHchangMH 'extremely' instead of henL 'very'.

Formally, we may propose a constraint *FOCUS/L, simply a type of *HEAD/L where the head in question is head of a focus phrase. This dominates various constraints on phrasing, including BINARITY. The following tableau shows the case of 'only buy stocks', where emphasis changes the preferred phrasing from (b) to (a):

(12) *Change in phrasing under focus*

| /L.L.L.HM/ | *FOCUS/L | BIN | *FOCUS/M,H |
|-----------------------------|----------|-----|------------|
| ☞ a. (L)(<u>MH</u> .L)(HM) | | ++ | + |
| b. (MH.L)(L.HM) | *! | | |

Note that *FOCUS/L doesn't *cause* sandhi to apply, otherwise L could become MH even before other tones. Tone sandhi is only triggered by the OCP banning LL sequences within the binary constituent, but *FOCUS/L selects between two different ways of applying it, by forcing a particular constituent structure.

Before we leave Mandarin, let me briefly show that an alternative account based on positional faithfulness is not a serious competitor. Positional faithfulness constraints such as HEADMAX-T require more diligent preservation of contrasts in privileged positions such as prosodic heads (see Beckman 1997, and Zoll 1998 for a dissenting view). They work well in capturing the loss of contrasts on non-heads, and their retention on heads, but there are two problems. First, they do not predict that each fully-toned syllable must be a head, since HEAD-MAX-T and *T between them prefer as few heads as possible, so the preference will be for one head per word, with tone loss on all other syllables. The actual stress facts of Mandarin must therefore be attributed to some other cause, such as syllable weight (Duanmu 1993). A more serious problem for a faithfulness account is that it does not generalize to the third-tone sandhi or focus cases, where H is inserted on heads in response to positional *markedness* preferences, despite seriously violating positional *faithfulness*.

We have seen that deLacy's approach can be extended to some additional cases rather elegantly. Despite this, there are certain types of phenomena it seems unable to handle, and it is to these I turn in the remainder of this paper.

3. The first challenge: an argument for positional faithfulness

In Shanghai Chinese, all tones of a phonological phrase are deleted except those of the left-most syllable, the head. The surviving tones are then re-distributed over the first two syllables, so that a /LH.HL/ input produces a [L.H] output, violating both *HEAD/L and *NON-HEAD/H. De Lacy's grammar would lead us to expect that the H of the head, and the L (if any) of the non-head would be retained. Clearly, the origin of the tones still matters, and there is thus no alternative to a positional faithfulness constraint such as HEAD-MAX-T. (cf Zoll 1997). Let us look at some representative data from Duanmu (1993); note that the tone of the second syllable disappears, and the tone of the first syllable splits and associates half with each syllable.

| | | | | | |
|------|-----------------------------|-------------|---|-------|----------------|
| (13) | <i>Shanghai tone sandhi</i> | | | | |
| | HL | se52 + pe52 | → | 55 21 | 'three cups' |
| | | se52 + bø23 | → | 55 21 | 'three plates' |
| | LH | sz34 + pe52 | → | 33 44 | 'four cups' |
| | | sz34 + bø23 | → | 33 44 | 'four plates' |

This contrasts with Mandarin where a falling-toned syllable keeps its fall when followed by a toneless syllable, although the fall may continue further on the second syllable: si53 ge → 53 21 (*55 21) 'four-CL'. Duanmu (1993) suggests that this difference follows from a difference in syllable structure. Shanghai syllables are mono-moraic, whereas Mandarin syllables are bi-moraic. If the TBU is the mora, Mandarin can accommodate both tones of a fall on one syllable, but Shanghai cannot, and thus one tone moves to the second syllable. Pre-pausally, Shanghai syllables lengthen, so in citation two tones can surface on a single syllable.

| | | | | | | | |
|------|------------------|-------|--|------------------|-------|-----|-----|
| (14) | <i>Mandarin:</i> | si ge | | <i>Shanghai:</i> | se pe | vs. | se# |
| | | μμ μ | | | μ μ | | μμ |
| | | / | | | / | | |
| | | HL | | | HL | | HL |

The problem remains that in the case of an input whose first syllable is /LH/, the output violates both highly ranked *HD/L and *NON-HD/H. More generally, in both Mandarin and Shanghai, nothing yet ensures that the retained tones are the tones that *originate* from the head, no matter what they are. Consider the following tableau. Tones are indexed to keep track of their origins. Candidate (a) preserves both tones of the first syllable, but violates both the positional markedness constraints. It will wrongly lose to candidate (b), which picks whichever tones better satisfy the positional markedness constraints, irrespective of their syllable of origin.

(15) *The wrong output for Shanghai, under a positional markedness account*

| /szL ₁ H ₁ peH ₂ L ₂ / | *NONHD/H | FAITH | *HD/L |
|--|----------|-------|-------|
| a. L ₁ . H ₁ | *! | ** | * |
| b. H ₁ . L ₂ | | ** | |

The fact is that underlying affinities still matter. Technically, this can be handled either (i) by ANCHOR-L, which simply restates left-headedness, or (ii) by a positional faithfulness statement such as this (from Yip 1999):

(16) HEAD-MAX-(F)

Every feature in the input associated in the input with a segment whose correspondent is contained in a prosodic head in the output has a correspondent in the output.

It is hard to see how this can possibly be done with positional markedness, given that the output may be maximally marked. I conclude that positional faithfulness may also be needed.

4. A second challenge: The need for positive markedness constraints?

Recall that de Lacy argues for two hierarchies of *negative* positional markedness constraints, *HD/T and *NON-HD/T, and disavows the need for *positive* positional markedness constraints that insist on particular tones in head and non-head positions, such as HD/H or NON-HD/L. Contra de Lacy, Wuming Zhuang, a Tai language of the N. Zhuang group, spoken in Guangxi province, China (Snyder and Lu 1997) seems at first glance to show the effects of a positive constraint HEAD/H. On sonorant-final syllables, Zhuang has six tones:

| | | | | | | |
|------|----|-----|-----------|----|-----|--------------|
| (17) | 55 | ha | 'five' | 33 | taw | 'chopsticks' |
| | 35 | sui | 'to wash' | 24 | pai | 'to go' |
| | 42 | yam | 'water' | 21 | muŋ | 'you' |

In the right syntactic and prosodic environment, tonal change affects the first syllable of a sequence as follows:

| | | |
|------|------------------|------|
| (18) | 35, 24, (and 55) | > 55 |
| | 33, 21, (and 42) | > 42 |

These changes take place if and only if one of the following circumstances holds:

- Both syllables are L register: ku33 ŋam21 > ku42 ŋam21 do-game 'play'
- Both syllables have identical tones (OCP):
yai35 kai35 > yai55 kai35 egg-chicken 'chicken egg'
- First syllable is 33, which nearly always changes:

pu33 tin55 > pu42 tin55 clothes-short 'short jacket'

d. Second syllable is stop-final, which the authors report to be much shorter, and deem "light", i.e. monomoraic.

yin24 mak33 > yin55 mak33 stone- ink 'ink-stick'

These changes are unusual in that the neutralization on the first syllable is in the direction of high and high falling tones, not to the usual unmarked low or mid tones. Two observations help us understand these changes. First, the output has a first syllable that is either more prominent than or as prominent as the second syllable, on the assumption that high pitch and prominence have an affinity for each other. Second, the exact form of the output tone is produced by the addition of a H tone to the start of the syllable, so that it starts high but ends on about its original pitch, so that the tones that end underlyingly on /5/ or /4/ become [55], and those that end underlyingly on /3/, /2/, or /1/ become [42].

These two observations suggest the following analysis. Zhuang is left-headed, and heads require H tone (as in Zoll 1997), triggering the insertion of a H tone at the left edge. Crucially, the insertion must be caused by a positive constraint HEAD/H, since unlike Lithuanian any underlying M or L tones are not deleted, but remain as part of a falling contour. Since underlying violations of de Lacy's *HEAD/M, L persist in the output, and are not alleviated by the addition of H, *HEAD/M, L cannot be the cause of the H insertion. Zhuang is also interesting because prominence-tone adjustments are made by augmenting the tones of the head instead of reducing the tones of the non-head, as has been more common in other systems we have seen. The following mini-grammar will produce the Zhuang data:

(19) ALIGN-L(HEAD, WD), HEAD/H >> DEP T

When we look more closely, however, another possible analysis suggests itself: Note that if the input is /35/, the addition of H still happens, and produces [55] not *[535], after deletion of the medial /3/. This suggests two refinements. First, there can be no more than two tones per syllable, or one per mora, and tones delete in order to satisfy this. Formally, ONET/μ >> MAX T. Secondly, the head syllable needs H on the first, head, mora, not just on any mora, else /35/ could satisfy Head/H without any change. We must thus revise our constraint to HEADMORA/H, requiring a H tone on the head mora.

This last move, however, opens up the possibility of handling these data within de Lacy's theory. Although the outputs may indeed have M or L tones in the head *syllable*, showing that *HEAD/M, L can't be sufficient, the outputs do *not* have M, L in the head *mora*. We could thus formulate a constraint *HEADMORA/M, L, and provided that all syllables are required to have tones, H will be the only remaining option, and all head moras will acquire an inserted H.

I conclude, then, that the Zhuang case, while suggestive, is not conclusive proof of the need for positive positional markedness constraints.

5. The third challenge: sequential markedness constraints?

De Lacy formulates all his constraints on level tones, without regard to context. Apparent preferences for particular sequences, such as the falls that attract stress in Mixtec, are atomized into constraints on the component level tones. Two cases in the literature suggest that this may not always be possible, because they make crucial reference to tonal sequences. The argument rests on the assumption that the published analyses offer the right insights, and that it should be possible to offer OT versions of these analyses. I will show that within de Lacy's approach this cannot readily be done.

5.1 Barasana

I will begin with the South American language Barasana, basing my account on a thoughtful paper by Gomez-Imbert and Kenstowicz 1999, based on fieldwork by the first author. Some background is needed to make the case. Barasana morphemes are H or HL, with an optional extra-tonal mora at the beginning which surfaces L, shown here with \diamond . Morphemic nasalization is omitted here. Roots are (C)V(C)V, with a few tri-moraic stems. Since some of these surface as HLL, and none as HHL, tonal association appears to be left-to-right, a situation of course familiar from African languages.

| | | | | | | |
|------|----|------|---------------|-------|----------|----------|
| (20) | H | gáwá | 'white people | <V>H | bujá | 'cotton' |
| | HL | wádi | 'fish sp.' | <V>HL | boká- bi | 'meet' |

Mono-moraic suffixes are toneless, and take their tone from the root, like the 3sg masc suffix /-bi/: [wáre- bí]'be awake' vs. [bíbi- bi]'suck'. Bi-moraic suffixes, however, may be HL. Their tone only surfaces after a H root; after a HL root, the suffixal HL is lost: /kubuH - aka HL/ > [kúbú-áka] 'shaman, dim', but /bidiHL-akaHL/ > [bídi-aka]. The table below shows the full array of possibilities. The last example in the first column has two HL affixes, and shows that the HL of an affix can also trigger deletion of a following HL.

(21)

| | H Roots | HL roots |
|-------------------|-------------------------|---------------------------|
| Toneless affixes: | kubu-re 'to the shaman' | bidi-re 'To the bird' |
| | // | // |
| | H | H L |
| /-re/ 'to' | <go>he-re 'to the hole' | <we>ko-re 'To the parrot' |
| | // | // |
| | H | H L |

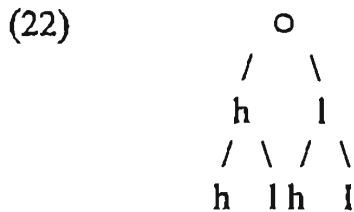
| | H Roots | HL roots |
|-------------------|--|--|
| HL affixes | kubu-aka 'Shaman, DIM' / H HL | bidi-aka 'Bird, DIM' /// HL HL → ∅ |
| /-akaHL/ 'DIM' | <go>he-aka 'hole, DIM' / H HL | <we>ko-aka 'Parrot, DIM' / // H L HL → ∅ |
| /-VriHL/ 'PL' | <go>he-Vri-aka-re 'to the little holes' / // / H HL HL → ∅ | |

In the case of a HL morpheme followed by another HL morpheme, the authors observe that in many languages HL is the melody associated with an accent, and that one property of accents is that a domain typically only allows one accent to survive. They propose that Barasana inverts this state of affairs, by accenting all HL's, and then assigning particular prominence to the first accent. Less prominent accents are then deleted. The crucial fact is that only the HL's participate in this accentual competition. Plain H's do not receive accent, and either trigger or undergo deletion.

We can now see the problem for de Lacy's theory, which has no way to place a head on a HL tone in preference to a H tone. The HL will always incur one additional constraint violation, specifically a violation of *HEAD/L. If we look at Barasana alongside Mixtecan, the commonality is that falling contours seem to be prominent. De Lacy cleverly reduced this in Mixtec to constraints on the component tones, but this strategy is not obviously extendable to the Barasana case.

5.2 Downstep:

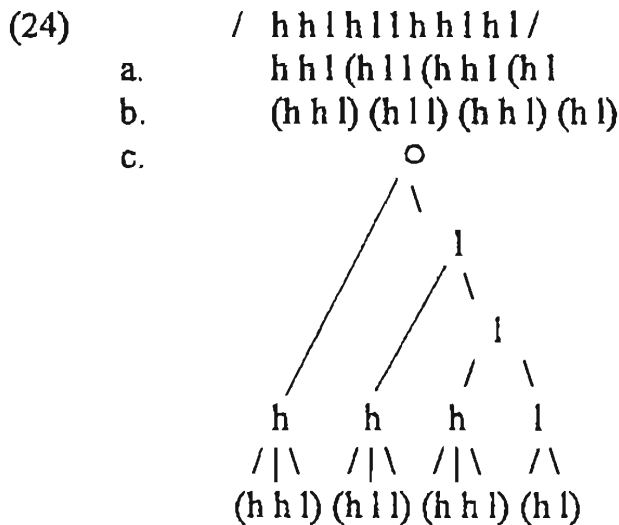
The second case in the literature in which sequences may need to be referred to involves downstep. Clements (1981) starts from the familiar observation that downstep takes place, proto-typically, when a H tone follows a L tone. Clements builds tonal feet, of the shape (h₁ⁿ l₁ⁿ). I follow Clements in using lower-case [h] and [l] here. These are then grouped into tree structures which are themselves labelled h, l. A // heading a constituent lowers the pitch of the whole constituent: So in the following structure, the second h will be lower than the first h, and the second l will be lower than the first l.



The structures are built by the following algorithm:

- (23) a. Start a new tonal foot between each /lh/ sequence.
 b. Gather any remaining tones into a tonal foot
 c. Group feet into a right-branching tree, labelled [h,l]

This builds trees step-by-step as follows, where (a-c) below are the result of following the corresponding steps in the algorithm above:



In OT, a derivational step-by-step approach is not available, so we must consider alternatives. A promising starting point is the constraints *HEAD/L and *NON-HEAD/H. These constraints will correctly prefer left-headed feet that are of the form (hl.l), and will disallow (lh...h). However, in downstep languages under Clements' account the acceptable feet are not just (hl.l) but also (hh..l). The middle positions are free to be H or L, as can be seen by looking at the first two feet in © above. *NON-HEAD/H can never distinguish between acceptable feet such as (hhl) and unacceptable feet such as (hlh), and so it cannot select between two possible footings of a /hlhhl/ string: the good footing (hl)(hhl) and the bad footing *(hlh)(hl) will tie. In De Lacy's system this is a general problem with n-ary feet: it cannot distinguish between allowing medial H's and disallowing terminal H's, since both are non-heads. So the good foot (hhl) and the bad foot (hlh) will tie in all cases. Appealing to alignment will not solve the problem, since if we rank ALIGN-L high enough to choose (hl)(hhl) over *(hlh)(hl) it will in fact pick the single-footed *(hlhhl).

De Lacy (p.c.) has proposed an analysis in which unbounded feet have a head at one

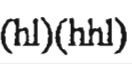
edge, a non-head at the other, and the medial positions are neither. This accounts directly for their tonal freedom. The lack of long feet containing (lh) sequences is achieved through the use of FT-BIN-MIN and FT-BIN-MAX. The problem with this interesting idea is that it expands the types of metrical distinctions from two (Head/NonHead) to three (Head/NonHead/Neither), a rather powerful move.

Let us try a different approach. The defining characteristic of these feet is that they are left-headed, and may not contain a (...lh...) sequence. A (lh) sequence is tonally speaking right-prominent, and thus fights the left-prominence of the foot's own requirements. Let us then assume that tonal prominence cannot undermine prosodic prominence: tonal reversals inside a foot are prohibited. Re-phrasing this: a tonal upturn signals an increase in prominence, and thus a new foot boundary. This reasoning underlies Clements' original first step: insert a foot boundary between every lh sequence. We may state this as a sequential constraint, sequential in the sense that a 'tonal profile' looks at a string of tones, not just one tone :

- (25) PROM-TONEMATCH: Prominence profiles and tonal profiles cannot contradict one another.

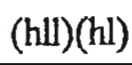
To complete the account, we shall assume that Align-L enforces the minimum number of feet consistent with this requirement. The first tableau deals with a string with consecutive medial H tones:

(26) Multiple medial H tones

| /hlhhl/ | PROM=TONE MATCH | ALIGN-L (FOOT, PHRASE) |
|--|-----------------|------------------------|
| a.  (hl)(hhl) | | ** |
| b. (hl)(h)(hl) | | *****! |
| c. (hlhhl) | *! | |

The second tableau considers an input with consecutive medial L tones:

(27) Multiple medial L tones

| /hllhl/ | PROM-TONE MATCH | ALIGN-L (FOOT, PHRASE) |
|---|-----------------|------------------------|
| a.  (hl)(hl) | | *** |
| b. (hl)(lhl) | *! | ** |
| c. (hllhl) | *! | *** |

6. Conclusions:

De Lacy's attractive theory is too restrictive in three ways:

- (i) Positional faithfulness constraints are needed to ensure that surviving tones originate from head position.
- (ii) Positive markedness constraints may be needed to explain the addition of H to heads, without loss of original L or M
- (iii) Sequential constraints that ban a tonal sequence such as ...lh... within a foot, are needed, at least for some accentual systems, and for systems with non-binary feet such as downstep languages.

So where do we go from here? One desirable tack would be to whittle away at these cases until they all succumb to de Lacy's account. An entirely different and much more controversial strategy is to question the OT tenet that all constraints are universal. Suppose that what is universal are only the connections between prominence and tone, not the precise way they are instantiated in the grammar. One language might require heads to have H tone, high-ranking the positive constraint HEAD/H, while another might ban heads from having low tone, high-ranking the negative constraint *HEAD/L. The child does not have to learn the connection: that is innate, but the child does have to decide which of the logical possibilities is the important constraint in his or her language. See Hayes 1996 on constraint acquisition by inductive grounding. Indeed, two children hearing the same language might well come to different conclusions.

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